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ABSTRACT

The National Science Foundation (NSF) annually publishes information generated by its survey of research and development (R&D) expenditures by United States industry. These data are collected for NSF by the U.S. Bureau of the Census. Other organizations also publish information on industrial R&D expenditures collected by surveys or derived from secondary sources. They include: (1) U.S. Securities and Exchange Commission; (2) "Inside R&D" newsletter; (3) "Business Week" magazine; (4) McGraw-Hill Publications Company; (5) "Research and Development" magazine; (6) Battelle Memorial Institute; and (7) Industrial Research Institute. This report examines NSF's annual survey and the seven additional sources of information on R&D spending and related activities. It includes a description of the information provided by each source, the definitions of R&D used, and the extent of coverage of the industrial sector. The report then proceeds to compare these items with those of the NSF survey. Information on how NSF and the seven other sources treat domestic R&D spending by foreign firms is included. (JN)

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NSF 85-311

related publications

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"Despite Recession, Companies' Own R&D Funding Rose 13% During 1982"	84-314	-----
"Dollar Value of U.S. R&D Expenditures Overseas Declined in 1982"	83-329	-----
Reviews of Data on Science Resources, No. 31. "A Comparison of National Industrial R&D Estimates with Actual NSF/Census Data"	78-303	$0.80
Detailed Statistical Tables		
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(See inside back cover for Other Science Resources Publications.)

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foreword

The industry sector is both the leading performer and largest source of funding of research and development in the United States. Thus, there is a strong interest among Federal and State legislators, budget officials, and industry officials in accurate and timely information on industrial research and development (R&D) activities. Several organizations, including the National Science Foundation (NSF) periodically publish data on industrial research and development including total expenditures, sources of funding, number of scientists and engineers, and sales.

This report examines NSF's annual survey of industrial research and development and seven other sources of information on R&D spending and related activities. It includes a description of the information provided by each source, the definitions of research and development used, and the extent of coverage of the industrial sector. The report then proceeds to compare these items with those of the NSF survey. These comparisons should be useful to policymakers in interpreting the findings of various studies that use one or more of the sources in their analyses.

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March 1985

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introduction

The National Science Foundation (NSF) annually publishes information generated by its survey of research and development (R&D) expenditures by U.S. industry. These data are collected for NSF by the U.S. Bureau of the Census. Other organizations also publish information on industrial R&D expenditures collected by surveys or derived from secondary sources. This report examines seven: U.S. Securities and Exchange Commission (SEC); *Inside R&D; Business Week;* McGraw-Hill Publications Company; *Research and Development* magazine; Battelle Memorial Institute; and the Industrial Research Institute (IRI). Three of these seven sources of information on R&D expenditures use the NSF/Census data as the base for their projections.

Frequently, inquiries question differences between NSF data and information published by different organizations. This report was prepared to explain the reasons underlying these differences.[1] The NSF/Census survey, which has been conducted annually for almost 30 years, uses a statistically weighted sample that represents firms in identified R&D-performing industries in the United States, including privately held and foreign-owned companies. The sample obtains at least 98 percent coverage of industrial R&D expenditures. To promote data consistency, the respondents are provided with detailed definitions of research and development. High levels of participation are ensured by the legal requirement to provide four key data elements: total R&D expenditures, Federal R&D expenditures, domestic net sales, and domestic employment. In view of these factors, the NSF/Census survey may be considered the most comprehensive overall source of industrial R&D data. Although several sources publish R&D information for other sectors of the economy, this discussion is confined to those covering R&D performance by U.S. industry. The methodology and content of each source are described individually.

[1] The Foundation published a similar comparison in May 1978: NSF 78-303. This report provides an update of that earlier work.

summary

Four sources of information on industrial R&D expenditures compared with the NSF/Census survey in this report provide estimates of total U.S. industrial R&D expenditures. Two other sources, *Inside R&D* and *Business Week*, which list individual companies and their R&D expenditures, do not provide estimates of R&D spending for the entire U.S. industrial sector. The seventh source, the SEC, does not aggregate data reported by individual companies.

Securities and Exchange Commission (SEC) forms 10-K and 10-Q are received each year from more than 10,000 companies. The SEC does not aggregate the collected data on either a total or an industry-by-industry basis. Publicly held companies with "material" expenditures for research and development are required by law to file selected R&D information in these submissions. Companies with R&D spending not large enough to be "material" (as interpreted by their accountants), privately held companies, regulated utilities, and transportation companies are generally exempt from filing R&D information. Thus, some firms with relatively large R&D programs are not required to supply R&D information to the SEC. In addition, company "R&D" data reported to the SEC may contain spending for activities that fall outside the scope of research and development as defined by NSF; e.g., engineering and technical services. SEC forms 10-K and 10-Q and information from company annual reports are the basis for estimates by *Inside R&D* newsletter and *Business Week* magazine.

Inside R&D uses data from the 100 largest R&D performers compiled by Standard and Poor's Compustat Services from the 10-K forms firms submit to the SEC. Estimates of the previous year's growth rate for total company-financed research and development for the 100 companies were each year within 3 percentage points of NSF/Census figures for the 1981-83 period. There are no data for individual industries.

Research and Development magazine publishes estimates of R&D funding for the ensuing year for each of the major sectors of the economy but not for individual industries. Estimates for both company and Federal funding are provided for total industrial research and development. These forecasts are based upon SEC reports (form 10-K), Federal Government budget data, company annual reports, and a telephone survey of about 45 companies. R&D forecasts for 1981-83 were annually 4 percent to 7 percent above NSF/Census data.

Battelle uses an economic model to project R&D expenditures by source and by performer, including individual industries, based upon NSF data. From 1981 to 1983 total industrial R&D projections were annually 6 percent to 10 percent below NSF figures; individual industry projections for those years differed from NSF/Census data by as much as 30 percent.

The Industrial Research Institute (IRI) in recent years periodically surveyed its membership, about 275 companies, to obtain information on anticipated relative changes in their own financing of research and development. The most recent survey covered 1984 and 1985. Results of these surveys cannot be directly compared with data from other sources because IRI reports only in terms of percentages of companies describing their R&D expenditures as "significantly less," "slightly less," "approximately the same," "slightly more," and "significantly more" for 1985 over the previous year.

Business Week also uses the Compustat Services data to estimate company-funded research and development for the previous year. Based on approximately 800 companies, *Business Week's* totals are about 10 percent lower than those of NSF/Census, but the former's annual growth rates for total company-funded research and development are very close to those of NSF/Census. *Business Week* also publishes R&D data for "industry composite" segments but these often differ from NSF's individual

industry classifications because the latter uses the Government's Standard Industrial Classification (SIC) system.

McGraw-Hill queries approximately 1,200 companies on expected R&D funding for the coming year and on percent-change estimates three years into the future. Estimates of industrial R&D spending, including both company and Federal funding, over the 1981-83 period ranged annually from 6 percent below to 1 percent above NSF/Census data. Individual industry estimates for each of those years have shown greater differences—as much as 26 percent.

Table 1 provides a ready reference to the information covered in the various surveys and estimates.

Table 1. Comparison of national R&D data

Items compared	Actual data				Estimates			
	NSF/ Census	SEC (Form 10-K)[1]	Inside R&D[2]	Business Week[3]	McGraw-Hill	Research and Development Magazine	Battelle	IRI[4]
Type of information provided	PD	PD	PD	PD	CE	CE	FE	NA
Differences between NSF/Census Bureau data for 1983								
Total industry basis	—	NA	NA	NA	-6%	-4%	-4%	NA
By individual industry (range)	—	NA	NA	[6]	-2% to -9%	NA	-16% to +4%	NA
Major data elements:								
Total industry R&D expenditures	Yes	No	No	No	Yes	Yes	Yes	No
Individual industry R&D expenditures	Yes	No	No	Yes[5]	Yes	No	Yes	No
Projection beyond 1983	Yes	No	No	No	Yes	No	No	Yes
Source of R&D funds	Yes	Yes	No	No	No	Yes	Yes	Yes
Net sales	Yes	Yes	No	Yes	No	No	No	Yes
Total company employment	Yes	Yes	No	No	No	No	No	Yes
Character of work	Yes[5]	No	No	No	No	No	No	No
Type of cost	Yes	No	No	No	No	No	No	Yes
Energy research and development	Yes	No	No	No	No	No	No	Yes
Pollution abatement research and development	Yes	No	No	No	No	No	No	Yes
Research and development contracted out	Yes	No	No	No	No	No	Yes	Yes
R&D employment	Yes	Yes	No	No	No	No	No	Yes[5]
Product/process research and development	Yes	No	No	No	Yes[5]	No	No	Yes
Capital R&D spending	No	No	No	No	No	No	No	Yes
Research and development performed abroad by U.S. companies	Yes	No	No	No	No	No	No	Yes
Regulatory research and development	Yes	No	No	No	No	No	No	Yes
Marketing/R&D relationship	No	No	No	No	No	No	No	Yes
1983 data available	9/84	4/84	6/84	7/84	5/83	1/83	12/82	NA

[1] Presented on an individual company basis.
[2] For 100 of the largest R&D spenders as reported to the SEC.
[3] For 800 of the largest U. S. companies as reported to the SEC.
[4] Actual dollar data not provided. Indications of changes in R&D funding levels are given only in nonquantitative terms.
[5] Indicates additional detail available.
[6] *Business Week*'s "industry composites" are not comparable with the NSF/Census industrial classification.

NOTES: PD means "past year data," CE means "current estimate," FE means "forward estimate," and NA means "not applicable."

SOURCE: National Science Foundation

definitions

Although not the primary cause of differences among the R&D expenditure totals reported by the sources, some definitional variations do exist. It is not possible to identify precisely the extent that these variations affect the information, because differences are caused by a combination of factors, such as sample size and the treatment of R&D outlays by subsidiaries of foreign-owned firms.

Of the eight sources of information on industrial R&D expenditures, Battelle and *Research and Development* magazine use the same definition as NSF/Census, and IRI uses virtually the same. The SEC definition applies to data published by *Business Week* and *Inside R&D*, whereas McGraw-Hill provides no definition.

nsf/census

Research and development includes basic and applied research in the sciences and in engineering, and design and development of prototype products and processes. Research and development includes activities carried on by persons trained, either formally or by experience, in the physical sciences including related engineering, and the life sciences including medicine but excluding psychology, if the purpose of such activity is to do one or more of the following things:

1. Pursue a planned search for new knowledge, whether or not the search has reference to a specific application.
2. Apply existing knowledge to problems involved in the creation of a new product or process, including work required to evaluate possible uses.
3. Apply existing knowledge to problems involved in the improvement of a present product or process.

securities and exchange commission

Industrial R&D data in *Business Week* and *Inside R&D* are taken from 10-K or 10-Q submissions to the *SEC*. In providing an R&D definition, the SEC instructs companies to list separately "If material, the estimated amount spent during each of the last three fiscal years on company-sponsored research and development activities determined in accordance with generally accepted accounting principles. In addition, state, if material, the estimated dollar amount spent during each of such years on customer-sponsored research activities relating to the development of new products, services or techniques or the improvement of existing products, services or techniques." The word "material" refers to the dollar amount of R&D spending. Company accountants use their discretion in determining whether their firms' R&D expenditures, as a percent of sales, are large enough to be listed separately in annual form 10-K submissions to the SEC.

Inquiries made in "response analyses" studies of the NSF/Census survey indicate that most company accountants are guided by Statement of Financial Accounting Standards No. 2, "Accounting for Research and Development Costs," promulgated by the Financial Accounting Standards Board (FASB), in reporting R&D expenditures both in their annual reports and in their 10-K submissions to the SEC. Staff from the FASB and NSF prepared the definition contained in Statement No. 2; consequently, the NSF/Census and FASB definitions of research and development are essentially the same. There are some wording differences. For example, NSF/Census includes pilot plants in connection with an R&D project, whereas the FASB definition includes facilities constructed for a particular R&D project for which there is no alternative use. NSF/Census instructions also ask companies to exclude research in the social sciences and psychology from their R&D expenditures.

whereas the FASB definition contains no reference to these two fields of science.

To understand better the effects of different reporting methods used by company accountants, the Census Bureau compared the R&D expenditure data provided by the top 200 R&D-performing companies in the NSF/Census survey with their SEC form 10-K submissions (table 3). Data from approximately one-third of the companies differed significantly because their 10-K data included such items as engineering and routine technical services. The R&D data, printed in *Business Week* and *Inside R&D*, are taken from form 10-K. Therefore, expenditures for engineering and routine technical services are sometimes included in the R&D data listed for companies in these two publications.

inside r&d

See SEC definition above.

business week

See SEC definition above.

mcgraw-hill

McGraw-Hill does not provide respondents with a definition of research and development. The questionnaire, does request the percent of total R&D spending allocated toward new products, new processes, and improving existing products.

research and development magazine

Uses NSF/Census definition. See above.

battelle memorial institute

Uses NSF/Census definition. See above.

industrial research institute

IRI uses a definition, developed in consultation with FASB, that appears to be essentially the same as that used by NSF/Census. Research and development are defined in the following manner by IRI:

Research is planned search or critical investigation aimed at discovery of new knowledge with the objective that such knowledge will be useful in developing new products/processes/services, or in bringing about a significant improvement to existing products/processes/services.

Development is the translation of research findings or other knowledge into a plan or design for new, modified, or improved products/processes/services whether intended for sale or use. It includes the conceptual formulation, design, and testing of product/process/service alternatives; the construction of prototypes; and the operation of initial, scaled-down systems or pilot plants. It does not include routine or periodic alterations to existing products, production lines, manul cturing processes, services and other on-going operations even though those alterations may represent improvements.

treatment of domestic r&d spending by foreign firms

All eight R&D reports include R&D expenditures in this country by U.S. companies. The *NSF/Census* survey funding totals include research and development performed within the United States by foreign-owned firms, but this is estimated to be less than 5 percent of total U.S. industrial R&D expenditures. In addition, the NSF/Census survey asks, as a separate data item, the dollar value of U.S. companies' research and development performed abroad, but this figure is shown separately from the totals for research and development performed in the United States.

SEC 10-K's include U.S. companies' expenditures on research and development performed abroad and some foreign companies' expenditures on research and development performed within the United States. SEC 10-K's are required of "companies with securities listed on national security exchanges, companies with securities traded over the counter which are registered under Section 12(g) of the Securities Exchange Act, and certain companies required to file pursuant to Section 15(d) of the Securities Exchange Act as a result of having securities registered under the Securities Act of 1933."[2] Registered companies which are "incorporated in a foreign country other than a North American country or Cuba are not required to file a 10-K form."[2] Companies required to submit 10-K's are instructed to report on foreign operations including research and development performed abroad.

Inside R&D uses SEC data. See above.

Business Week uses SEC data. See above.

McGraw-Hill asks for "R&D performed in your company in the United States." Forms are sent to foreign firms trading on U.S. stock exchanges if they have operations, such as R&D facilities, in the United States.

Research and Development magazine includes expenditures on research and development performed in the United States by foreign companies and excludes funds spent on research and development performed abroad by U.S. companies.

Battelle also includes expenditures on research and development performed in the United States by foreign companies and excludes funds spent on research and development performed abroad by U.S. companies.

IRI surveys only its members, several of which are foreign-owned companies performing research and development in the United States. It is not clear from IRI's survey form or from the instructions whether or not companies should include in their totals research and development performed outside the United States.

* * * * * * * *

In the remainder of this report, each of these sources of industrial R&D information is described in detail, including, where appropriate, tables showing relative differences between amounts published by each source and NSF/Census data.

[2] U.S. Securities and Exchange Commission, *Directory of Companies Required to File Annual Reports*, July 31, 1984, p. 1.

analyses of specific surveys

Title: Survey of Industrial Research and Development

Performers: NSF/Census

Description: Survey designed to obtain total U.S. R&D performance data from a statistically valid sample of industrial firms undertaking research and development in the United States.

The sampling unit for the survey is the company, defined as a business organization consisting of one or more establishments under common ownership or control. The sample for this survey is drawn approximately every five years. The most recent sample of 11,500 companies was selected for the 1981 survey from two sources: the 1981 Standard Statistical Establishment List (SSEL) for single units and the 1981 Enterprise Statistics multiunits file.

Approximately 1,500 companies from this sample are mailed the survey form every year. Each of these firms either spends at least $1 million of its own and/or Federal funds on research and development annually or is included to obtain 95 percent coverage (of total R&D expenditures) of a particular industry. In the absence of respondent data, which averages less than 2 percent for total R&D expenditures, the Bureau of the Census estimates data for items as required in accordance with past performances and industry averages.

The remaining companies in the sample receive a survey form only for the year the sample is drawn. In nonsample years, estimated data for these companies are based on actual data from other companies with similar characteristics receiving and completing the survey form annually.

In addition, each year Department of Defense and National Aeronautics and Space Administration lists of R&D contractors are reviewed by the Census Bureau staff to ensure that companies receiving R&D funding awards from these agencies are included in the survey.

Questionnaires are mailed in January following the year to be surveyed. Preliminary results are available in late summer. Complete data are available in a publication entitled *Research and Development in Industry (Detailed Statistical Tables)* 12 to 18 months after the survey year. The most recent detailed data cover 1982 and are contained in *Research and Development in Industry, 1982* (NSF 84-325). Unpublished preliminary data for 1983 are also available.

Information on sampling ratios and standard error of estimates are included in final survey reports, together with definitions and descriptions of the survey methodology and limitations of the data.

Frequency: Annual

Key elements: Includes R&D expenditures by source of funds, total domestic net sales, total domestic employment, R&D scientists and engineers, projected company R&D outlays, type of R&D cost, fields of basic research, applied research and development by product field, geographic distribution of R&D expenditures, energy research and development by source of funds and type of energy source, pollution abatement research and development, research and development performed outside the company, and research and development performed abroad. These statistics are provided for the total sample and on an industry-by-industry basis; e.g., the machinery industry, etc.[3]

This is a statistically valid survey of research and development. Also, because this survey collects more data elements than the other surveys, it affords a broader understanding of industrial R&D performance.

Companies are required by law to report total R&D expenditures, Federal R&D expenditures, and domestic net sales and employment, thus providing virtually complete coverage of the large R&D performers on these items. The response rates for the voluntary questions,

[3] The aggregation of data for some items by individual industry affords a greater level of detail than other surveys.

however, are lower. When a company fails to provide data for a particular question, the Census Bureau must impute (estimate) the firm's expenditures, using industry averages. If an imputation rate for a particular industry exceeds 50 percent, the data are not published, although they are used in computing totals for the various R&D categories. In addition, data for some items are not published because of possible disclosure of R&D expenditures made by individual companies.

The standard error of estimate for the survey is less than 0.5 percent. Standard errors for individual industries for 1982 are contained in table 2.

Table 2. Standard error of estimate (percentage) of funds for R&D performance for all company size-groups and for companies with less than 1,000 employees by industry: 1982[1]

Industry	SIC code	Standard error[2]	Standard error of companies with less than 1,000 employees
Total	.....	(3)	10
Food and kindred products	20	1	21
Textiles and apparel	22,23	3	22
Lumber, wood products, and furniture	24,25	2	23
Paper and allied products	26	1	36
Chemicals and allied products	28	1	9
Industrial chemicals	281-82,285	(3)	16
Drugs and medicines	283	3	15
Other chemicals	284-85,287-89	2	14
Petroleum refining and related industries	29	(3)	6
Rubber products	30	3	32
Stone, clay, and glass products	32	1	23
Primary metals	33	1	22
Ferrous metals and products	331-32,3398-99	(3)	15
Nonferrous metals and products	333-36	4	26
Fabricated metal products	34	2	18
Machinery	35	1	11
Office, computing, and accounting machines	357	(3)	15
Other machinery, except electrical	351-56,358-59	2	10
Electrical equipment	36	1	17
Radio and TV receiving equipment	365	1	20
Communication equipment	366	1	19
Electronic components	367	(3)	17
Other electrical equipment	361-64,369	2	41
Motor vehicles and motor vehicles equipment	371	(3)	14
Other transportation equipment	373-75,379	1	9
Aircraft and missiles	372,376	1	91
Professional and scientific instruments	38	2	20
Scientific and mechanical measuring instruments	381-82	4	32
Optical, surgical, photographic, and other instruments	383-87	(3)	8
Other manufacturing industries	21,27,31,39	1	13
Nonmanufacturing industries	07-17,41-67,737, 739,807,891	7	27

[1] Data are not available for 1983.
[2] The percentage (or relative) standard errors in this table may be converted to standard errors of estimate by multiplying the percentage shown by the associated estimate.
[3] Less than 0.5 percent.

SOURCE: Bureau of the Census

Title: Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934 (Form 10-K)

Performer: U.S. Securities and Exchange Commission

Description: Consists of reports from all publicly held companies. Data must be filed within 90 days after the fiscal year to which the report applies. Thus, most 1983 data were available in the spring of 1984. R&D data are not aggregated by the SEC. Individual company reports, however, are available to the general public.

Frequency: Annual

Key elements: On an individual company basis—R&D expenditures by source of funds; R&D scientists and engineers employed by source of funds; sales; profits.

Comparability to NSF/Census Survey: Privately held companies, regulated utilities, and transportation companies, some of which perform substantial amounts of research and development, are generally not required to submit 10-K reports, whereas the NSF/Census survey collects R&D data for these firms. In addition, companies with R&D expenditures judged by their accountants as too small to be "material" do not report R&D figures separately to the SEC.

The Census Bureau staff compared *Business Week's* compilations of 1976, 1981, and 1983 R&D data (from form 10-K) with R&D data on companies' own R&D funding supplied by individual firms responding to the NSF/Census survey. Data from each source for the top 200 R&D-performing firms (according to the NSF/Census survey) were compared. These comparisons revealed that the difference between the two sources in overall R&D spending increased from 3 percent in 1976 and 1981 to 8 percent in 1983.

The Census Bureau staff also adjusted each company's NSF/Census and 10-K data to make them as comparable as possible. To do this, the amount of funds provided to outside organizations in R&D contracts and the amount of R&D funds spent abroad were added to com-

pany-financed U.S. R&D expenditures. (These three data elements are reported separately in the NSF/Census survey.) Each company's total was then compared with that firm's 10-K data (which already included the costs of research and development contracted out and performed abroad). Once these adjustments were made, the remaining variation for a particular company appeared to be largely attributable to the inclusion in the 10-K form of engineering and routine technical services along with R&D expenditures. For example, 9 of the 50 largest R&D spending companies included engineering in the 1983 R&D figures they reported to the SEC.

Data for 1983 from the top 200 R&D-performing companies were found to vary as follows: 62 companies supplied data in the NSF/Census survey that were within 2 percent of their 10-K submissions; data for 32 companies differed by 3 percent to 10 percent; data for 44 companies differed by 10 percent to 25 percent; and data for 26 companies differed by more than 25 percent. In addition, 36 companies were not included in the *Business Week* compilation, primarily because they were privately held or foreign-owned.

Table 3 shows the results of the Census comparison on an aggregated industry basis.

Table 3. NSF/Census and SEC form 10-K reports comparison of R&D expenditures from the RD-1 survey and 10-K reports for the top 200 Census R&D companies: 1976, 1981 and 1983

Industry	Code	Percent difference of SEC 10-K figure to RD-1 figure		
		1976	1981	1983
Total		− 3	− 3	− 8
Food and kindred products	20	+ 9	− 1	+ 1
Textiles and apparel	22,23	[1]	[1]	[1]
Lumber, wood products, and furniture	24,25	1	0	+ 2
Paper and allied products	26	+25	−12	0
Chemicals and allied products	28	+ 2	+17	+ 3
Industrial chemicals	281-82,286	+ 1	+17	+ 1
Drugs and medicines	283	+ 4	+23	+ 4
Other chemicals	284-85,287-89	0	− 7	+ 1
Petroleum refining and related industries	29	− 7	+ 8	+ 8
Rubber products	30	+14	+13	+23
Stone, clay and glass products	32	+10	+ 5	+ 9
Primary metals	33	− 8	− 6	(D)
Ferrous metals and products	331-32,3398-99	0	+ 6	(D)
Nonferrous metals and products	333-36	− 14	+ 6	(D)
Fabricated metal products	34	+ 6	− 5	− 6
Machinery	35	+ 6	− 24	− 9
Office, computing, and accounting machines	357	− 8	−27	−13
Other machinery, except electrical	351-56,358-59	NA[2]	−13	− 8
Electrical equipment	36	−12	− 7	−32
Radio and TV receiving equipment	365	NA	−19	(D)
Communication equipment	366	−14	−13	−48
Electrical components	367	− 2	−19	−10
Other electrical equipment	361-64,369	−11[2]	−15	−11
Motor vehicles and motor vehicles equipment	371	− 3	− 9	−13
Other transportation equipment	373-75,379	NA	− 2	(D)
Aircraft and missiles	372-376	− 7	+ 7	+ 9
Professional and scientific instruments	38	+11	+ 3	+ 4
Scientific, mechanical, and measuring instruments	381-82	− 6	+ 3	− 1
Optical, surgical, photographic, and other instruments	383-87	+14	+ 3	+ 8
Other manufacturing industries	21,27,31,39	−33	−30	− 1
Nonmanufacturing	7-12,14-17, 41-67,739, 807,891	− 7	0	−28

[1] None of the top 200 R&D companies is in this industry.
[2] Not separately available but included in total.
[3] Includes radio & TV receiving equipment.

NOTE: (D) Data withheld to avoid disclosing individual company information.

SOURCE: "Survey of Industrial Research and Development, 1983" Bureau of the Census and *Business Week*, July 9, 1984.

Title: 100 Biggest R&D Spenders in U.S. Industry

Performer: *Inside R&D* newsletter

Description: *Inside R&D* lists information acquired from Compustat presentations of companies' form 10-K's filed with the SEC for the 100 largest spenders of company R&D funds. *Inside R&D* does no surveying or data collection of its own. The company data for the previous year are published the first week of June, e.g., 1983 data were published in the June 6, 1984, newsletter. *Inside R&D* provides an estimate of the percentage increase in total company funds for research and development, comparing data from the year under discussion with those from the previous year. *Inside R&D* advises readers that R&D expenditures of the 100 companies are approximately 77 percent of industry-funded research and development performed in the United States. Data are not aggregated into individual industries.

Frequency: Annual

Key elements: On an individual company basis—company-funded R&D expenditures, percentage change from previous year, R&D as a percent of sales, net income as a percent of sales, R&D funds spent per employee. On an industry-wide basis—an estimate of the increase in the current year's company-funded research and development.

Comparability with NSF/Census Survey: *Inside R&D* aggregates the data from the 100 companies and does not attempt to estimate the amount spent on all company-funded research and development performed in the United States. A comparison of the annual percentage increases reported by *Inside R&D* with those of the NSF/Census data for the 1981-83 period showed that the two sets

of data were within 3 percentage points of each other (table 4).

Table 4. Inside R&D and NSF/Census comparison of increases in company R&D funds: 1981-83

Year	NSF/Census percent change from previous year	Inside R&D percent change from previous year
1981	+16	[2] +13
1982	+13	[2] +13
1983	+ 9	[3] +10

[1] *Inside R&D* data from the annual report on the 100 Biggest R&D Spenders in U. S. Industry, June 2, 1982, June 1, 1983, and June 6, 1984.
[2] Based on 50 companies.
[3] Based on 100 companies.

SOURCE: National Science Foundation

Title: R&D Scoreboard

Performer: *Business Week* magazine

Description: Estimates of company-funded R&D spending for U.S. industry and for individual industries, i.e., "industry composites," based on data for 800 companies compiled by Standard and Poor's Compustat Services from 10-K data submitted to the Securities and Exchange Commission. *Business Week* tallies the data for approximately 800 companies meeting its R&D spending criteria ($1 million or 1 percent of sales) and then reports the spending increase for the total of those companies. No attempt is made to estimate total U.S. industry R&D spending. *Business Week* assigns and aggregates the company data into "industry composite" classifications. Previous year's data are available in late June or early July.

Frequency: Annual

Key elements: On individual company and "industry composite" basis—profits, R&D expenditures, research and development as a percent of sales, research and development as a percent of pretax profits, and R&D funds spent per employee.

Comparability with NSF/Census Survey: *Business Week* includes 800 companies; the R&D total is about 10 percent lower than that of NSF/Census. Estimates of the annual change in company-funded R&D spending for the 800 companies are only 1 percentage point different from those of NSF/Census between 1981 and 1983 (table 5). Individual industry comparisons are difficult because *Business Week*'s "industry composite" groupings cannot be disaggregated to match the SIC code groupings of industries used by NSF/Census.

Table 5. Business Week and NSF/Census comparison of increases in company R&D funds: 1981-83

Year	NSF/Census percent change from previous year	Business Week[1] percent change from previous year[2]
1981	+16	+15
1982	+13	+12
1983	+ 9	+10

[1] *Business Week* data from July 5, 1982, June 20, 1983 and July 9, 1984 issues.
[2] Based on 800 companies.

SOURCE: National Science Foundation

Title: Business' Plans for New Plant and Equipment, R&D Section

Performer: McGraw-Hill Publications Company

Description: As part of a survey of approximately 1,800 companies on capital investment in industry, McGraw-Hill annually surveys 1,200 companies on R&D expenditures. Responses are received from more than 300 firms. The survey requests total (including company and Federal) R&D expenditures in the preceding year, and projected 1-year and 3-year percentage increases. These percentages are applied to previously published NSF/Census figures to yield R&D projections for both total and individual industries for the ensuing year and for three years into the future. The estimates are usually available in May. McGraw-Hill published 1984 estimates in a May 1984 release entitled "Twenty-ninth Annual McGraw-Hill Survey of Business' Plans for Research and Development Expenditures, 1984-87."

Frequency: Annual

Key elements: Previous and current year figures for research as a percent of sales, and research and development as a percent of capital spending. Projections are made for R&D expenditures; new product sales; new products as a percent of sales; and percent of R&D expenditures used for new products, new processes, and improvement of existing products.

Comparability with NSF/Census Survey: McGraw-Hill does not provide respondents with specific definitions, and the R&D expenditure estimates are published without information on survey methodology, weighting for nonresponse, and imputation rates. Although a survey followup is conducted, the response rate is low. Since definitions and instructions are not provided, estimates may include capital expenditures for some companies but not for others; some companies may report research and development contracted out, whereas others report only intramural R&D activities; and market research expenditures may be included in some company responses. A comparison of overall McGraw-Hill estimates with NSF/Census data for the 1981-83 period shows that each year their rates of change were within 3 percentage points of each other (table 6). On an individual industry basis, the variations were much greater (table 7).

Table 6. McGraw-Hill and NSF/Census comparison of increases in total industrial R&D funds: 1981-83

Year	NSF/Census percent change from previous year	McGraw-Hill[1] percent change from previous year
1981	+16	+17
1982	+14	+17
1983	+ 9	+ 8

[1] McGraw-Hill estimates from 26th, 27th, and 28th Annual McGraw-Hill Surveys (May 1981, 1982, and 1983).

SOURCE: National Science Foundation

Table 7. McGraw-Hill and NSF/Census comparison of total R&D expenditures for selected industries: 1981-83

[Dollars in millions]

Industry	NSF/Census	McGraw-Hill[1]	Percent difference
	1983		
Total	$64,401	$60,794	− 6
Chemicals and allied products	7,208	6,826	− 5
Primary metals and fabricated metals products	[2]NA	1,378	NA
Machinery	8,399	7,874	− 6
Electrical equipment and communication	14,059	12,750	− 9
Motor vehicles and other transportation equipment	5,502	5,399	− 2
Aircraft and missiles	14,553	13,506	− 7
Professional and scientific instruments	NA	4,741	NA
Other manufacturing	NA	6,348	NA
Nonmanufacturing	NA	1,972	NA
	1982		
Total	58,960	59,743	+ 1
Chemicals and allied products	6,588	6,663	+ 1
Primary metals and fabricated metals products	1,575	1,631	+ 4
Machinery	7,879	8,939	+13
Electrical equipment and communication	11,925	12,949	+ 9
Motor vehicles and other transportation equipment	4,962	6,270	+26
Aircraft and missiles	14,045	11,736	−16
Professional and scientific instruments	4,047	3,300	−18
Other manufacturing	5,771	6,328	+10
Nonmanufacturing	2,168	1,927	−11
	1981		
Total	$51,810	$50,514	− 3
Chemicals and allied products	5,625	5,465	+ 3
Primary metals and fabricated metals products	1,502	1,307	−13
Machinery	6,818	6,425	− 6
Electrical equipment and communication	10,329	11,596	+12
Motor vehicles and other transportation equipment	[2]4,929	5,543	+12
Aircraft and missiles	11,968	9,097	−24
Professional and scientific instruments	3,614	2,695	−25
Other manufacturing	[3]NA	NA	NA
Nonmanufacturing	NA	2,666	NA

[1] McGraw-Hill estimates from 26th, 27th, and 28th Annual McGraw-Hill Surveys (May 1981, 1982, and 1983).
[2] Estimated by Industry Studies Group, NSF.
[3] NA means "not available."

SOURCE: National Science Foundation

Title: Forecast for R&D Funding

Performer: *Research and Development* magazine

Description: Forecast of national R&D expenditures for the entire economy, by the four major R&D-performing sectors, i.e., industry, the Federal Government, universities, and other nonprofit organizations, for the ensuing year. Industry estimates are based primarily on NSF/Census survey results, Securities and Exchange Commission (form 10-K) reports, company annual reports, and a telephone survey of approximately 45 companies. The telephone survey is conducted in late November. Federal funding estimates are based on Federal budget and appropriations data. Estimates for the year are published in the January issue of the magazine. No estimates are shown for individual industries.

Frequency: Annual

Key elements: Estimates of R&D expenditures by source of funds for the current year.

Comparability with NSF/Census Survey: Company-financed R&D expenditures and total R&D funds are published for the industry sector. The informal survey sample used for the industry estimate, however, is not statistically valid because not all industries are adequately represented. The difference between *Research and Development* magazine's annual total estimates and NSF actual figures has become smaller over the past few years (table 8).

Table 8. *Research and Development* magazine and NSF/Census comparison of company R&D funds: 1981-83

Year	NSF/Census percent change from previous year	*Research and Development* magazine[1] percent change from previous year
1981	+16	+14
1982	+13	+12
1983	+ 9	+10

[1] *Research and Development* magazine estimates from January 1981, 1982, and 1983 issues.

SOURCE: National Science Foundation

Title: Probable Levels of R&D Expenditures: Forecast and Analysis

Performer: Battelle Memorial Institute

Description: Projections of total R&D funds by source and by performer for ensuing year. Individual industry projections are also made. All projections employ a Battelle-generated model that incorporates data from the NSF R&D series, SEC reports, and other secondary sources. No survey is conducted. Projections are available annually in December in the Battelle publication "Probable Levels of R&D Expenditures, Forecast and Analysis." The latest information available in this series, published in December 1984, is projections for 1985 and for 1986.

Frequency: Annual

Key elements: R&D projections for industry as both a source of R&D funds and an R&D performer; company research and development by individual industries; cost of research index.

Comparability with NSF/Census Survey: Battelle uses the latest available NSF/Census data as a statistical base for its projections. Battelle's projections for total industry research and development between 1981 and 1983 were, each year, 6 percent to 10 percent below NSF/Census data, and there were larger differences at the individual industry level (tables 9 and 10). Battelle bases its projections in December in part on economic factors which may change during the ensuing year; this may explain some of the differences between those projections and NSF/Census actual data.

Table 9. Battelle and NSF/Census comparison of increases in company R&D funds: 1981-83

Year	NSF/Census percent change from previous year	Battelle[1] percent change from previous year
1981	+16	+13
1982	+13	+11
1983	+ 9	+ 8

[1] Battelle projections from "Probable Levels of R&D Expenditures, Forecast and Analysis," December 1980, 1981, and 1982.

SOURCE: National Science Foundation

Title: IRI Trends Survey

Performer: Industrial Research Institute (IRI)

Description: A survey of IRI members (about 275 companies) on various aspects of research and development. IRI members include almost all large U.S. R&D performers with the exception of some major aerospace companies. The most recent questionnaire was mailed in the early summer of 1984 and asked for total R&D spending changes to be categorized in a unique manner (e.g., "slightly less," "significantly more,"—terms which were not defined) for the ensuing year. Information is not presented for individual industries. The findings were published in the March-April 1985 issue of *Research Management* magazine.

Frequency: Annual, beginning in 1984; periodic in earlier years

Key elements: Survey requests estimates of annual changes rather than absolute levels of expenditures or personnel. Respondents are asked to project changes for R&D expenditures; direct salaries and wages attributable to research and development; capital spending for R&D operations; research and development contracted out; grants and contracts for research and development performed by universities; distribution of R&D costs

Table 10. Comparison of NSF/Census actual data with Battelle projections of company R&D funds: 1981-83

[Dollars in millions]

Industry	NSF/Census	Battelle[1]	Percent difference
	1983		
Total	$43,386	$40,751	− 6
Food and kindred products	[2]NA	723	NA
Chemicals and allied products	6,764	6,150	− 9
Petroleum refining and extraction	NA	2,161	NA
Stone, clay, and glass products	NA	511	NA
Primary metals	NA	803	NA
Fabricated metals products	NA	711	NA
Machinery	7,246	7,546	+ 4
Electrical equipment and communication	9,034	7,621	−16
Transportation equipment and missiles	8,475	8,553	+ 1
Professional and scientific instruments	NA	3,213	NA
Other manufacturing	NA	1,762	NA
Nonmanufacturing	NA	997	NA
	1982		
Total	$39,901	$37,186	− 7
Food and kindred products	745	720	− 3
Chemicals and allied products	6,155	5,270	−14
Petroleum refining and extraction	2,002	1,556	−22
Stone, clay, and glass products	418	478	+14
Primary metals	727	907	+25
Fabricated metal products	512	583	+14
Machinery	7,020	6,656	− 5
Electrical equipment and communication	7,336	6,436	−12
Transportation equipment and missiles	8,346	8,815	+ 6
Professional and scientific instruments	3,401	2,721	−20
Other manufacturing	2,059	2,049	0
Nonmanufacturing	1,180	995	−16
	1981		
Total	$35,428	$31,960	−10
Food and kindred products	636	645	+ 1
Chemicals and allied products	5,205	4,735	− 9
Petroleum refining and extraction	1,790	1,453	−18
Stone, clay, and glass products	411	457	+11
Primary metals	702	713	+ 2
Fabricated metals products	545	407	−25
Machinery	6,124	6,023	− 2
Electrical equipment and communication	6,409	6,043	− 6
Transportation equipment and missiles	7,739	6,564	−15
Professional and scientific instruments	2,978	2,087	−30
Other manufacturing	1,851	1,990	+ 8
Nonmanufacturing	1,048	843	−20

[1] Projections from "Probable Levels of R&D Expenditures, Forecast and Analysis," Battelle Memorial Institute, December 1980 (for 1981), December 1981 (for 1982), and December 1982 (for 1983).
[2] NA means "not available."

SOURCE: National Science Foundation

into support of existing businesses, directed basic research, and new-business projects; the ratio of noncentralized to centralized corporate R&D efforts; research and development for customer technical services; research and development for existing or proposed legislation; R&D professional and support employment; new graduates hired; top management attention to research and development; number of new ventures; licensing technology from others; licensing technology to others; extent of Government R&D support; R&D expenditures as a percent of sales; and operational costs per R&D professional.

Comparability with NSF/Census Survey: Since the IRI survey asks for descriptive changes in R&D funding (i.e., "significantly less," "slightly less," "approximately the same," "slightly more," and "significantly more") without providing percentage ranges to guide companies in selecting appropriate categories, it is difficult to compare IRI's findings with those of NSF/Census. Data comparisons are further inhibited by two additional factors: All responses are treated equally regardless of the size of the companies' R&D programs, and some major aerospace companies did not participate.

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"7% Real Growth Expected in 1985 National R&D Expenditures: Defense and Economy Major Factors"	85-304	-----
"Defense and Space Research and Development Emphasized in 1985 Budget"	84-333	-----
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Detailed Statistical Tables

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Federal Funds for Research and Development, Fiscal Years 1983, 1984, and 1985, Volume XXXIII	84-336	-----

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